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EFFECTS OF DROUGHT ON THE YIELD AND YIELD COMPONENTS OF MAIZE (*ZEA MAYS* L.)

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Abstract

Drought stress is an abiotic factor affecting growth and yields of crop plants and one of themost important limiting factors for maize growth and productivity in many places across the world. To evaluate the effect of water deficit stress and nutrient levels on yield, yield components and grain nutrient quality levels, this experiment was carried out as factorial based on randomized complete block design with 3 replications in a biculture field.

Two levels of water treatment were applied thus, non-irrigated and irrigated and three levels of nitrogen treatment (control, 80kg, 120kg) were used.

In this study, NDVI, Protein, and moisture content were significantly affected by water stress whiles Yield, LAI, Protein, starch and moisture content were significantly influenced by nitrogen treatments.

Key words; Maize, Drought,Nutrition, Yield, Crop Rotation**,**

INRTODUCTION

Maize (*Zea mays* L.) is a major cereal crop worldwide, serving as a major staple for both human consumption and animal feed. It has also become a key resource for industrial applications and bioenergy production.It is a versatile crop andranks third following wheat and rice in world production as reported by Food and AgricultureOrganization (FAO. 2002).

Maizeis highly productive under optimal environmental and crop management conditions. However, maize plants are also very susceptible to drought and heat; each year, an average of 15% to 20% of the potential world maize production is lost due to these stresses (Lobell et al. 2011).

Drought and temperature extremes can cause extensive economic loss to agriculture (Boyer 1982; Peng et al. 2004; NCDC 2011)

Drought stress or water deficit is an inevitable and recurring feature of global Agriculture. Kramer (1980) reported that about one-third of the world'spotentially arable land suffers due to water shortage, and most of the crops production is often reduced by drought.

Drought is a worldwide phenomenon and is a major production constrain, reducing crop yields. The extent of climate change over the next 20 years and it impact are difficult to predict but it is essential to put research in place now that will be needed in the long term.(Parry, et al.,2007)

The maize crops may experience reductions of grain yields when subjected to water deficit during the critical period of crop cycle from tasseling stage to initiation of grain filling.

During 1998/99 a long drought period, 48.8 mm rain only allowed grain yield of 4.8 t/ha. While during the year 2002/03 a short duration drought at critical period reduced grain yield less than 2 t/ha, affecting the ear per plant and kernel per ear (Bergamaschiet al., 2004). Drought stress usually goes along with high temperature. In this conjunction drought has even more accentuated detrimental effects on crop production (BARNABAS et al., 2008).

The effect of drought on crop production like maize and its economic losses, Particularly during flowering and grain-setting stage has been reported (Abdelmula & Ebrahim-sabile, 2007; Setter et al., 2001).

Drought stress reduces the leaf area (Pandey et al., 2000), plant height (Soler et al., 2007), shoot growth (Stoneet al., 2001a), and grain yield (Payeroet al.,2006).

Water deficit at reproductive stage accelerates the leaf senescence, inhibitsphotosynthesis, reduces the assimilate supply, and thus, decreases the rate and duration of grain filling. Setter et al. (2001)

MATERIALS AND METHODS

This research was carried out in the Latokep Research site of the University of Debrecen in the cropping year of 2017. The experimental site is located at Hajdusag ridge, about 15 Km way from the city center of Debrecen and its geographical coordinates are 47^{o}33’ N, 21^{o}27’ E.

The experimental soil is flat and leveled and the soil genetic properties belong to the calcareous chernozem. The experiment was set up on a split-split-plot design in four replication. The research was carried out based on a two-factorial parameters and these are the nutrition levels(control, 80kg of Nitrogen and 120kg of Nitrogen), and different irrigation treatment(Full irrigation and non- irrigation) on a plot of landwith plant density of (72,500/ha^{-1}).

The factors that were considered in this study included, the morphological and physiological parameters (SPAD, LAI, NDVI) as well as yield and components thus, Cob length, cob diameter, number of rows per cob, number of kernel per row, etc. The grain moisture and nutritional content were also measured at harvest.

In the irrigation treatment,optimal water-supply of plants shall be reached by adapting irrigation water amounts to the local temperature and precipitationvalues for the cropping season (2017).In the end of the cropping season of 2017, the deviation in April, July and September was positive, thus the lack of precipitation in the other months was balanced and the total precipitation of the season was higher 379.9 mm than the 30-years average of 345.1. (Table 1)

Table1

Monthly precipitation and deviations from the 30-years average values in the vegetation of maize (Debrecen - Látókép, 2017)

	2017		**30-years average (mm)**
	value (mm)	**deviation (mm)**	
march	24.5	-9	33.5
April	50.4	8	*42.4*
May	31.9	-26.9	*58.8*
June	62.3	-17.2	*79.5*
July	71.6	5.9	*65.7*
August	47.5	-13.2	*60.7*
September	91.7	53.7	*38*
Total	**379.9**	**1.3**	***345.1***
Average temperature (^{0}C)	**16.3**	**0.2**	***16.9***

The results of data for this study were processed and statistically evaluated using software Microsoft Excel and SPSS for windows. This study was planned to examine effect of drought stress on yield and yield components of maize under different water and nutrient treatments on a biculture crop rotation field.

RESULTS AND DISCUSSION

From the analysis of data collected for this study, the irrigation treatment had a significant effect on NDVI, Protein and Moisture content at harvest at 5% probability as shown in (Table1).

Water treatment and plant nutrient (Nitrogen treatment) did not have effect on yield and yield component except on the cob length where water stress had a significant effect on the cob length at the probability level of 5%. Studies have shown seed yield and yield a component of maize was greatly influenced by irrigation treatment (Rivera-Herandez et al., 2010, Cakir, 2004).

This study also shows a significant effect on the leaf area index (LAI) and moisture content at 5% probability level and 1% probability level on protein and starch content of the grains at harvest. The effect of Nitrogen on the crude protein of maize cannot be over emphasized as it has been reported by (Haque et al., 2001) that, inadequate supply of nitrogen could cause retarded growth in maize owing to be a constituent of protein and nucleic acid. Similarly, according to (Ayub *et al.*, 2002a) Nitrogen application could increase the nutritive value of grain dueto increase in grain crude protein concentration. In this research, yield was not significantly affected by water stress thought the irrigated field recorded a high value of 6350.63kg/ha as against the non-irrigated field of 6178.88kg/ha(Table3). This study relates to (Classen and Shaw,1970b) also observed significant grain yield reduction (12-15%) due to water deficit at vegetative stage and 53% grain yield reduction due to water deficit at 75% silking stage. Water deficit at reproductive stage accelerates the leaf senescence, inhibits photosynthesis, reduces the assimilate supply, and thus, decreases the rate and duration of grainfilling. (Setter et al., 2001) also reported that pre-pollination and post-pollination water deficit reduce the kernel number and kernel size of the corn. Maize cob length was significantly affected by irrigation treatment in this research. (Table3). The effect of water stress on NDVI was clear in this study as shown in Table 2. The warning effect of drought on photosynthesis was very clear at the stem elongation stage of maize development. The low level of photosynthesis rate on the maize plant could have an impact on food construction and also impact on the dry matter accumulation. Other researchers such as (Kisman, A., 2003) and (Osborne et al 2002) have also reported the effect of water limitation on photosynthesis and dry weight loss on maize.

Table 2

Effects of water treatment and nutrient levels on photosyntheticand nutrition quality of seeds

CROP RATATION BICULTURE	SPAD	NDVI	LAI	PROTEIN	STARCH	MOISTURE
NON IRRIGATION	54.88	77.44*	2.33	8.88*	74.08	17.29*
FULL IRRIGATION	53.30	74.29	2.60	9.27	74.00	18.22
CV%	2.11	2.26	0.48	0.33	0.46	0.70
NUTRIENT LEVEL						
CONTROL	55.20	76.87	2.96*	8.32**	74.65**	17.07*
80Kg-N	53.67	75.27	2.24	9.12	73.98	17.70
120kg-N	53.40	75.47	2.20	9.78	73.48	18.50
CV%	2.58	2.77	0.59	0.44	0.57	0.86

Note: * correlation is significant at 0.05 level, ** correlation is significant at 0.01 level

Table 3

Effects Of Water Treatment And Nutrient Levels On Yield And Yield Parameters

CROP RATATION BICULTURE	HEIGHT(cm)	COBWEIGHT(g)	COBLENGTH(cm)	NO OF ROWS/COB	YIELD(kg/ha^{-1})
NON IRRIGATION	251.02	221.12	19.02*	15.56	6178.88
FULL IRRIGATION	243.82	241.57	20.16	16.41	6350.63
CV%	7.28	28.70	0.95	2.83	30.78
NUTRIENT LEVEL					
CONTROL	248.00	242.82	19.60	15.33	5146.16*
80Kg-N	246.77	222.49	19.91	14.78	6455.75
120kg-N	247.50	228.73	19.26	17.83	6934.73
CV%	8.92	35.1	1.16	3.46	0.236

Note: * correlation is significant at 0.05 level, ** correlation is significant at 0.01 level

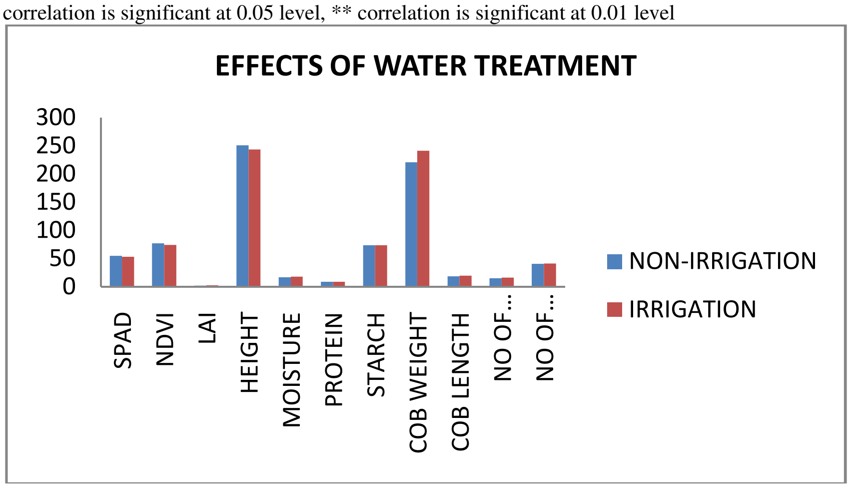

Fig.1. Effect of water treatment maize

CONCLUSION

Crop production in any location in the world cannot be carry out meaningfully without enough water supply to the crops, but unfortunately, due to climate changes and its impact on the environment, most crops are grown in many parts of the world without enough water supply at some parts of the crops developmental stages. It is against this background that, research should be put in place to carry out the impact or effects of water deficit on the vegetative and reproductive yield and yield components of maize plant.

From this study, water stress and nitrogen treatment has negative impact on yield and nutritional quality of the maize grains and so researchers and farmers at large should be paying attention to these factors when planning their growing activities.

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